

axes; or the parts of a molecule may oscillate about their common centre of mass; (7) All oscillations are either ordered or unordered motions.

The various types of oscillation are held by Dr. Fischer to account respectively for chemical light-vibrations, electric light-vibrations, heat, gravity, electric and magnetic phenomena.

While Madame Royer's speculations on the nature of things lead her to think that the laws of nature are never disturbed by "that imaginary being called God, who has no place in an autonomous universe," Dr. Fischer concludes his paper with the quotation

"Die Himmel erzählen des Ewigen Ehre."

We far prefer the spirit of the latter writer, who in the course of his work clearly sees that theories of matter can but be approximate mechanical representations of the truth. It is true that a good deal of progress has been made of late years in the conception of elements and media which reproduce more or less closely the physical phenomena known to us; but whether we regard the universe as filled with a single medium and atoms as singularities occurring in it, or regard everything, including the ether, as built up of discrete atoms, a reduction of the number of varieties of atoms and media is not necessarily synonymous with an advance in physical theory. What is rather wanted is to reduce to their minimum the number of fundamental hypotheses required for the mathematical deduction of the physical phenomena known to us. This was the spirit which actuated Maxwell, and while since his time we have become more and more familiar with molecules and the ether, it is doubtful whether our advances in reducing their properties to mathematical formulæ have been so great as they ought to be. With the exception of Larmor, there are few physicists now carrying on the work of Maxwell, and there is, unfortunately, a growing school who conceal their ignorance of the causes of things by referring everything to "molecules" or "the ether," and endowing these with new properties without troubling much if such properties are reconcilable with those previously attributed to them. What is equally important, as our theories of matter advance, fresh properties become known to us, so that as soon as we have climbed to the summit of one hill, we see a still higher one ahead. G. H. B.

ALLEGED HYPOSTOMIAL EYES IN THE TRILOBITES.

Researches on the Visual Organs of the Trilobites. By G. Lindström. Kg. Svn. Vet. Akad. Handlg., Stockholm. Bd. 34, No. 8. Pp. 74; 6 plates. (1901.)

THIS memoir of 74 pp., illustrated by six most beautiful plates, deals in reality with the joint labours of the author whose name appears upon the title-page and his talented assistant, G. Liljevall, to whom the first detection of the central fact of the presence of supposed eyes on the labrum (hypostome), the labour of cleaning and preparing the specimens described, and, above all, of making the original drawings (for which no praise can be too high) are due. The material described is mostly a rich collection preserved in the Swedish National Museum; but it is explained, with NO. 1640, VOL. 63]

comment none too flattering, that "collections of foreign species and the waste (vast) European and American literature" have been taken into account. The work opens with a short introduction, dealing mainly with the detailed surface anatomy of the hypostome and the orientation of the supposed hypostomial eyes, or "maculæ," as the authors name them, together with an account of the first observations upon which, by comparison with the cephalic eyes of the compound type, they were led to regard the maculæ of the faceted kind as visual in function. There then follows a chapter upon the blind Trilobites. A detailed dissertation upon the origin and nature of the ridge hitherto designated the "eye-lobe," "ocular fillet," or "Augen Leiste," and known by a variety of other names, next follows; and the authors, finding that "in a long series of genera succeeding each other it has no connection whatever with any eye," prefer to term it the "facial ridge"; and they subdivide the blind species into series characterised by its presence or absence.

In the foregoing section much is made of the young larvæ of *Olenellus*, discovered by Ford and Walcott, as furnishing a clue to the development of this facial ridge, and of the fact that during the growth process of the higher forms the pygidium follows the head region in order of appearance, and that the intervening "thorax" or body-segments are intercalary in origin. Passing to detail concerning the head, Bernard's terms, "rhachis" and "pleura" are preferably employed, and in dealing with its anatomy a passing compliment is paid to the Japanese embryologist, Kishinouye. Attention is next drawn to an important series of growth stages of *Liostracus*, described by Brögger in 1875, but generally overlooked, and from the study of these the conclusion is reached that the developmental changes of the head segments in the higher Cambrian and Silurian forms are of a different order to those of the *Olenellidæ* and *Paradoxidæ*, which Dr. Lindström would apparently regard as representative members of distinct series; and the final result is arrived at that the earliest oculate genus was *Eurycare* of the *Olenellus* schists, and that *Olenus* and *Parabolina* were probably blind.

The succeeding section is devoted to the consideration of the eyes of the Trilobites, the detailed structure of which the authors, with immense labour, have investigated, by sections taken at various planes and by other means at their disposal. They have been thus enabled to distinguish four types of cephalic eye, which they believe to have probably succeeded one another in the following order, viz. the simplest or Harpes type, of simple ocelli; the *Eurycarid*, biconvex or lentiform type; the *Megalaspid* or prismatic type; and the *Phacopsid* or "aggregate" type—each of which is duly figured with as much detail as is forthcoming, and in section as observed for thirty-six species. Further detail under this head is impossible in these pages; and we pass at once to the fuller consideration of the "maculæ," or hypostomial eyes so-called.

Although the authors record these organs for some 136 species of thirty-nine genera, they state at the outset that the genera in which they have found them lens-bearing are relatively few, and that the lenses or "granules," even where recognisable, have been found to be present only

over the lower third of the macula, with the exception of the Asaphidæ, Illænus and Lichas, of which they remark the entire macula shows "the structure which characterises" it as a visual organ. Beyond this, the macula, for which an average diameter of 0.99 mm. is given, is described as "oblong or ellipsoidal, and for two-thirds of its surface perfectly smooth or rather glossy," and its "granules" or lenses are estimated to be but 0.055 mm. in diameter at their largest.

With the maculæ, as with the cephalic eyes, a wide range of modification is recognisable, which, if the authors' assumption of a visual function for the former be correct, leaves little doubt that the faceted type is for it a culminating one. They state that the maculæ, "whether they show any organic structure or not," have commonly an "excessive thinness of their shell," and in so far as they enter into comparison with other Crustacea, while they call attention to the similarity "in the formation of the superior surface of the head in the Trilobites and the embryos and newly-hatched larvæ of Limulus," they incline to the belief that, concerning the cephalic eyes, Limulus "stands completely isolated amongst all Arthropods," except for a certain resemblance between its cornea and that of Peltura." They similarly deny resemblance to the Phyllopods, and regard "the eyes of the Trilobites" as showing "the greatest conformity with those of the recent Isopods."

Full perusal of the details which they attribute to the hypostomial macula shows them to have discovered an interesting and important organ. Comparison is instituted between it and a thin area of the hypostome of the living Apus; but, if sound, there is not much to be said from this standpoint for the "eye" theory in any but the faceted forms. For the types which remain, the study of the remarkable details described in the memoir leaves us in doubt as to the evidence for the supposed visual function. Convinced of its actuality, however, in an attempt to bring the living Crustacea into line, the authors fall back upon the fact that in the embryo Limulus the median eyes have been described by Packard and others as originally ventral, and that there have been recorded for the Lepadidæ two ventro-lateral eyes in an adult by Darwin, two ventro-lateral and a ventro-median one in a larva by Claparede, and similar indications by Hesse and Spence Bate.

Remarking upon the supposed habits of the Trilobites, of which we know nothing very definite beyond that a burrowing habit has been suggested, our authors express themselves averse to the popular idea that they "lived in abyssal depths . . . where the most intensive darkness prevailed." There are, however, considerations arising out of recent discovery concerning these animals worthy of note in this association. Owing to the wonderful conditions for preservation which characterise the Utica slate deposits near Rome, N.Y., certain Trilobites, during the last six to seven years there unearthed, as all zoologists are well aware, in the hands of Dr. Beecher, of Yale College, Conn., have yielded results of importance second to none in the palæontology of the period. The proof that but one pair of antennæ were alone present, and that they were uniramous, brings the adult Triarthrus at once into line with the Nauplius larva, as distinct from all other known Crustacean forms; while that of a simple

uniformly jointed condition of the post-oral appendages, most, at least, of which were biramous, and of the Phyllopodan tendency of those posterior and last developed, more than fulfils the highest expectations of the philosophic morphologist, and amply justifies our trust in the larval form. One conspicuous feature of these appendages is the recurrent development from each of an inwardly directed and tapering gnathobase, most assuredly concerned with its fellows in the seizure of the prey and, by transfer of this from limb to limb, with its passage to the mouth. We know nothing of the habits of these animals as they swam, but from this feature the possibility is suggested that, like the living Apus, they may have swum upon their backs; and, if so, the presence of hypostomial eyes would become the more readily intelligible. On the other hand, the possibility that the "maculæ" may have been luminous organs must not be overlooked; and bearing upon this surmise, it is well to remember that such organs are known to exist in a lenticulate and aggregated form, and that the probable presence of one of simple type in a sponge, taken in conjunction with the extent to which like organs are functional as a lure to the prey, would dispose of any anomaly in their possession by blind animals. And finally, inasmuch as the remarkable organs present in the Chitons, some of which, being lens-bearing, were by Moseley described as eyes, so far as experiment with light has yet progressed, have given but negative results, it becomes a question whether, until we know more concerning even these, the term "æsthete" may not be well extended to them all. Arguing by analogy from these to the Trilobite "maculæ," it must be admitted that their visual function is not proved.

In the further inquiry into the nature of these remarkable organs there lies a most promising field. As we cannot experiment with them, we provisionally retain an open mind concerning their functions; and while we are profoundly grateful to our authors for their intensely interesting memoir and the great labour they have bestowed upon it, we shall await with much interest the further results of their inquiry.

G. B. H.

THE RELATIONS OF THE OSTRICH-LIKE BIRDS.

On the Morphology and Phylogeny of the Palaeognathæ (Ratitæ and Crypturi) and Neognathæ (Carinatæ).
By W. P. Pycraft. *Trans. Zool. Soc. London*, vol. xv.
pp. 149-290, pls. xlii-xlv.

THE relation of the flightless ostrich-like birds (Mr. Pycraft says we must no longer call them Ratitæ) to more typical representatives of the class Aves has long been one of the puzzles of ornithology, and it is therefore a matter for satisfaction that the author of this important memoir has undertaken the task of revising and extending our knowledge of the anatomy of the existing members of the former group. The work was undertaken in connection with Mr. Walter Rothschild's revision of the cassowaries, of which, indeed, it forms the sequel; and the thorough manner in which it has been carried out forms a model of what such researches should be, and enables zoologists to draw their own conclusions on the questions at issue, if they are unable to accept all those at which the author arrives.